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XII. *Some Observations on the Irritability of Vegetables.**By James Edward Smith, M. D. F. R. S.*

Read February 14, 1788.

HAVING often heard that the stamina of the Barberry, *Berberis communis*, were endued with a considerable degree of irritability, I made the experiment in Chelsea Garden, May 25, 1786, on a bush then in full flower. It was about one o'clock P. M. the day bright and warm, with little wind.

The stamina of such of the flowers as were open were bent backwards to each petal, and sheltered themselves under their concave tips. No shaking of the branch appeared to have any effect upon them. With a very small bit of stick I gently touched the inside of one of the filaments, which instantly sprung from the petal with considerable force, striking its anthera against the stigma. I repeated the experiment a great number of times; in each flower touching one filament after another, till the tips of all six were brought together in the center over the stigma.

I took home with me three branches laden with flowers, and placed them in a jar of water, and in the evening tried the experiment on some of these flowers, then standing in my room, with the same success.

In order to discover in what particular part of the filaments this irritability resided, I cut off one of the petals with a very
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fine pair of scissars, so carefully as not to touch the stamen which stood next it: then, with an extremely slender piece of quill, I touched the outside of the filament which had been next the petal, stroaking it from top to bottom; but it remained perfectly immoveable. With the same instrument I then touched the back of the anthera, then its top, its edges, and at last its inside; still without any effect. But the quill being carried from the anthera down the inside of the filament, it no sooner touched that part than the stamen sprung forwards with great vigour to the stigma. This was often repeated with a blunt needle, a fine bristle, a feather, and several other things, which could not possibly injure the structure of the part, and always with the same effect.

To some of the antheræ I applied a pair of scissars, so as to bend their respective filaments with sufficient force to make them touch the stigma; but this did not produce the proper contraction of the filament. The incurvation remained only so long as the instrument was applied; on its being removed, the stamen returned to the petal by its natural elasticity. But on the scissars being applied to the irritable part, the anthera immediately flew to the stigma, and remained there. A very sudden and smart shock given to any part of a stamen would, however, sometimes have the same effect as touching the irritable part.

Hence it was evident, that the motion above described was owing to an high degree of irritability in the side of each filament next the germen, by which, when touched, it contracts, that side becomes shorter than the other, and consequently the filament is bent towards the germen. I could not discover any thing particular in the structure of that or any other part of the filament.

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This irritability is perceptible in stamina of all ages, and not merely in those which are just about discharging their pollen. In some flowers which were only so far expanded that they would barely admit a bristle, and whose antheræ were not near bursting, the filaments appeared almost as irritable as in flowers fully opened; and in several old flowers, some of whose petals with the stamina adhering to them were falling off, the remaining filaments, and even those which were already fallen to the ground, proved full as irritable as any I had examined.

From some flowers I carefully removed the germen, without touching the filaments, and then applied a bristle to one of them, which immediately contracted, and the stigma being out of its way, it was bent quite over to the opposite side of the flower.

Observing the stamina in some flowers which had been irritated returning to their original situations in the hollows of the petals, I found the same thing happened to all of them sooner or later. I then touched some filaments which had perfectly resumed their former stations, and found them contract with as much facility as before. This was repeated three or four times on the same filament. I attempted to stimulate in the midst of their progress some which were returning, but not always with success; a few of them only were slightly affected by the touch.

The purpose which this curious contrivance of nature answers in the private œconomy of the plant, seems not hard to be discovered. When the stamina stand in their original position, their antheræ are effectually sheltered from rain by the concavity of the petals. Thus probably they remain till some insect coming to extract honey from the base of the flower, thrusts

thrusts itself between their filaments, and almost unavoidably touches them in the most irritable part : thus the impregnation of the germen is performed ; and as it is chiefly in fine sunny weather that insects are on the wing, the pollen is also in such weather most fit for the purpose of impregnation. It would be worth while to place a branch of the Barberry flower in such a situation, as that no insect, or other irritating cause, could have access to it ; to watch whether in that case the antheræ would ever approach the stigma, and whether the seeds would be prolific.

I have been the more particular in these observations upon the Barberry, because although several authors mention the irritability of its stamina, none, that I can find, have related in what part of the stamina this property resides, or the purpose it serves ; at least they have not pursued their inquiries with any great degree of accuracy, but seem mostly to have copied one another. GMELIN, who has written a dissertation expressly on the irritability of vegetables, has scarcely any thing new on the subject ; the chief part of his work is a catalogue of plants which he found *not* to be irritable.

The Barberry is not the only plant which exhibits this phenomenon. The stamina of *Cactus Tuna*, a kind of Indian Fig, are likewise very irritable. These stamina are long and slender, standing in great numbers round the inside of the flower. If a quill or feather be drawn through them, they begin in the space of two or three seconds to lie down gently on one side, and in a short time they are all recumbent at the bottom of the flower. The motions in *Dionæa muscipula*, *Mimosa sensitiva* and *pudica*, are too well known to be mentioned here. A similar phenomenon has been observed, where indeed an obvious botanical analogy would lead one to expect it, in the *Drosera*.

See Dr. WITHERING's Botanical Arrangement of British Plants. All these movements are, I think, certainly to be attributed to irritability. We must be careful not to confound them with other movements, which, however wonderful at first sight, are to be explained merely on mechanical principles. The stamina of the *Parietaria*, for instance, are held in such a constrained curved position by the leaves of the calyx, that as soon as the latter become fully expanded, or are by any means removed, the stamina, being very elastic, fly up, and throw their pollen about with great force. I have lately observed a similar circumstance in the flowers of *Medicago falcata*. In this plant the organs of generation are held in a straight position by the carina of the flower, notwithstanding the strong tendency of the infant germen to assume its proper falcated form. At length, when the germen becomes stronger, and the carina more open, it obtains its liberty by a sudden spring, in consequence of which the pollen is plentifully scattered about the stigma. The germen may at pleasure be set at liberty by nipping the flower so as gently to open the carina, and the same effect will be produced.

As the foregoing experiments shew vegetables to possess irritability in common with animals, so there are plants which seem to be endued with a kind of spontaneous motion. LINNÆUS having observed that the Rue moves one of its stamina every day to the pistillum, I examined the *Ruta chalepensis*, which differs very little from the common Rue, and found many of the stamina in the position which he describes, holding their antheræ over the stigma; while those which had not yet come to the stigma were lying back upon the petals, as well as those which, having already performed their office, had returned to their original situation. Trying with a quill to
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stimulate the stamina, I found them all quite devoid of irritability. They are stout, strong, conical bodies, and cannot, without breaking, be forced out of the position in which they happen to be. The same phænomenon has been observed in several other flowers; but it is no where more striking or more easily examined than in the Rue.

I could wish to find an instance of this spontaneous motion combined with irritability in one and the same plant; but, I confess, I do not know one. From analogy I should think it not impossible that the *Dionæa muscipula*, and perhaps the *Drosera*, may have the same motion in their stamina as the *Ruta*, *Parnassia*, and *Saxifraga*, while their leaves possess irritability. But if this be the case, the seats of these two properties, being so different and remote from each other, should seem to have as little connexion as if in two different plants. There still remains then this difference between animals and vegetables, that although some of the latter possess irritability, and others spontaneous motion, even in a superior degree to many of the former, yet those properties have hitherto in animals only been found combined in one and the same part. Even *Sertulariæ* are not an exception to this observation. The greater part of their substance, indeed, resembles that of plants in being indefinitely extended, and in wanting irritability and spontaneous motion. But their animated flowers or polypes, in which the essence of their being resides, are endued with both these properties in an high degree.

I know it is the opinion of some philosophers that a certain degree of irritability must pervade every part of vegetables, as the propulsion of their fluids cannot well be conceived to be accomplished by any other means. In a conversation on this subject with the celebrated M. BONNET, of Geneva, he

informed me, that he is strongly of this opinion ; and that he should not despair, by throwing acid or other stimulating injections into the vessels of some plants, of seeing with a microscope at once the propulsion of the sap, and the contractions by which it is performed. He urged me, with that amiable enthusiasm for which he is remarkable, to pursue the inquiry. Whether I do so or not, I think the idea too-interesting to be kept to myself, and should be glad to see it realized by any one who has time and abilities for such investigations, who has accuracy and coolness in making his experiments, as well as fidelity and impartiality in recording them.

I cannot conclude this Paper without taking notice of another very curious property which vegetables seem to possess in common with animals, although certainly in a very inferior degree : I mean, that property, to use the words of Mr. HUNTER, who has studied this principle to a vast extent in the animal œconomy, by which their constitution is capable only of a certain degree of action consistently with health ; when that degree is exceeded, disease or death is the consequence. It is only by the help of this principle that I can explain why many plants resist a great degree of cold for several winters before flowering ; but, after that critical event, they perish at the first approach of cold, and can by no art be preserved so as to survive the winter. But a more curious instance is that mentioned by LINNÆUS, without an explanation, in his Dissertation on the Sexes of Plants, of the long duration of the pistilla in the female hemp, while unexposed to the male pollen ; whereas those to which the pollen had access immediately faded and withered away. In this case, I cannot help thinking, that in those pistilla on which the pollen had acted, and which consequently had performed the function for which they were designed,

designed, the vital principle was much sooner exhausted than in those which had known no such stimulus. It is, perhaps, for the same reason that double flowers, in which, the organs of generation being obliterated, no impregnation can take place, last much longer in perfection than single ones of the same species, as is notoriously the case with Poppies, Anemonies, &c. In single Poppies the corolla falls off in a few hours; but in double ones it lasts several days; and this may possibly, combined with other observations, lead to a discovery of the real use of the corolla of plants, and the share it has in the impregnation, about which there has yet been no probable conjecture.

